



Laporan Akhir Projek Penyelidikan Jangka Pendek

Ceramic Foam Core Sandwich Composites for Structural Applications

by

Prof. Dr. Hj. Zainal Arifin Hj. Ahmad

Assoc. Prof. Dr. Hazizan Md. Akil

Mohd Al Amin Muhamad Nor

Shahrul Ami Zainal Abidin

2008



Construction Industry Development Board Malaysia

LAPORAN AKHIR

**KOMPOSIT SANDWIC BERTERAS BUSA
SERAMIK UNTUK KEGUNAAN STRUKTUR**

***CERAMIC FOAM CORE SANDWICH
COMPOSITES FOR STRUCTURAL
APPLICATIONS***

(LPIPM:CREAM/UPP03-02-05-01(1))

30 Oktober 2008

CREAM
Construction Research
Institute of Malaysia



USM

UNIVERSITI SAINS MALAYSIA

Ringkasan Eksekutif

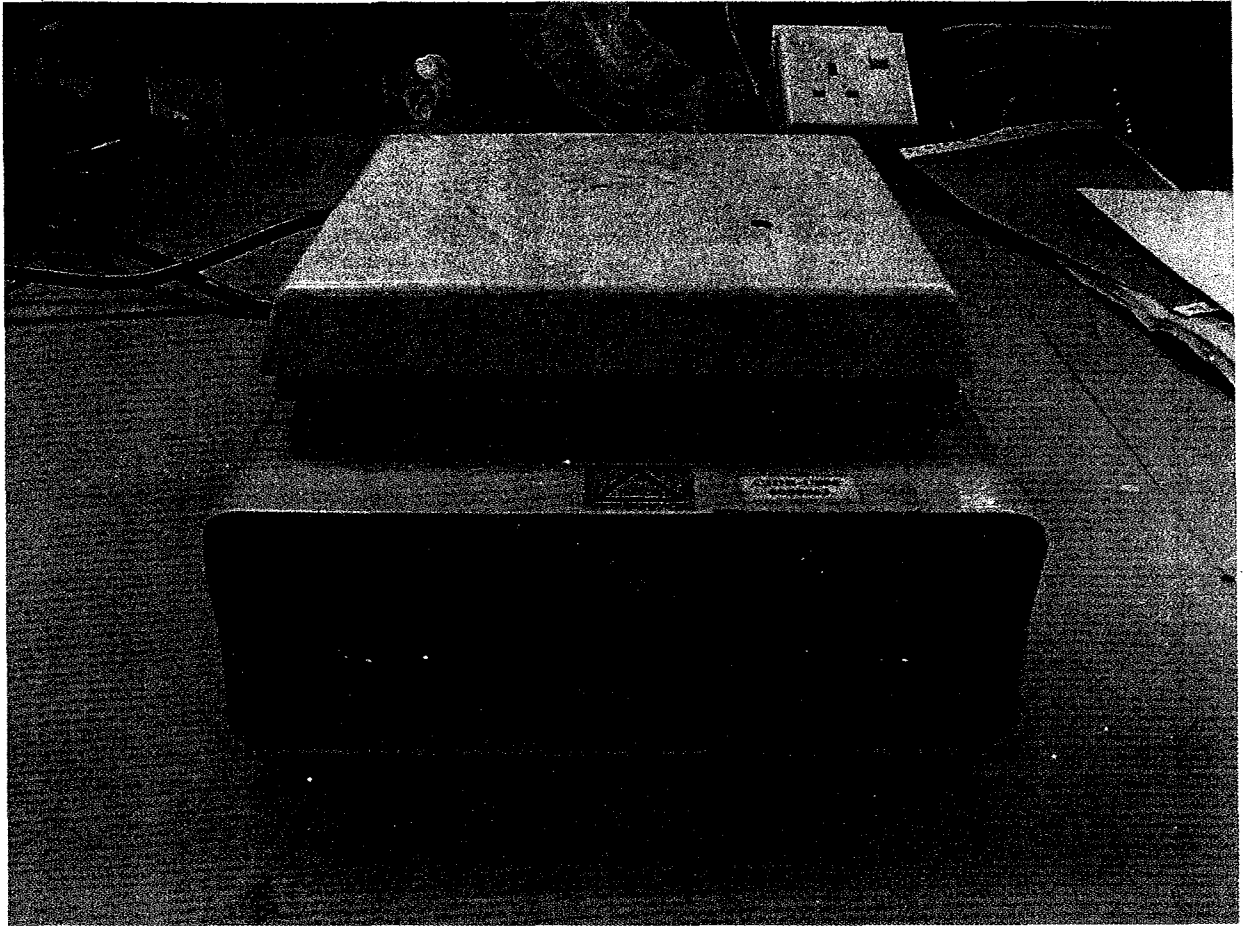
"*Ceramic Foams Core Sandwich Composite for Structural Applications*" adalah projek usahasama antara Universiti Sains Malaysia (USM) dan Lembaga Pembangunan Industri Pembinaan Malaysia (CIDB). Projek ini dibiayai oleh CIDB dengan geran berjumlah RM 452,000.00 selama dua tahun iaitu bermula pada 15 September 2004 hingga 31 Ogos 2006. Namun begitu, bayaran pertama sebanyak 25% hanya dapat dilakukan pada 31 Januari 2005 semasa Mesyuarat Pengurusan Pertama bertempat di Bilik Mesyuarat CREAM, Tingkat 10, CIDB, Kuala Lumpur. Kumpulan penyelidik USM dianggotai seramai empat ahli iaitu Prof. Dr. Hj. Zainal Arifin Hj. Ahmad (Ketua Projek), Dr. Hazizan Md. Akil (Penyelidik Bersama), En. Mohd Al Amin Muhamad Nor (Pegawai Penyelidik) dan En. Shahrul Ami Zainal Abidin (Juruteknik Kanan). Penyelidikan berjalan lancar dengan semua keperluan bahan mentah, peralatan, bahan bacaan dan radas-radas kecil dapat diperolehi dalam tempoh yang ditetapkan. Walau bagaimanapun, tempoh lanjutan selama 4 bulan (sehingga 31 Disember 2006) diperlukan untuk menyempurnakan penyelidikan ini. Semua tahap pencapaian (*milestones*) projek yang ditetapkan telah dipatuhi dan dicapai. Selain itu, pasukan penyelidik juga menyediakan beberapa laporan dan dokumen tuntutan yang antaranya termasuk laporan kemajuan kerja, laporan pencapaian *milestone*, laporan kewangan dan laporan akhir projek yang diperlukan pihak CIDB. Laporan akhir projek penyelidikan ini merupakan laporan menyeluruh hasil dari kerja-kerja penyelidikan yang dijalankan sehingga 31 Disember 2006. Di akhir laporan ini turut disediakan spesifikasi teras busa seramik yang telah berjaya dihasilkan serta potensinya untuk dibangunkan secara komersil sebagai bahan teras komposit.

Executive Summary

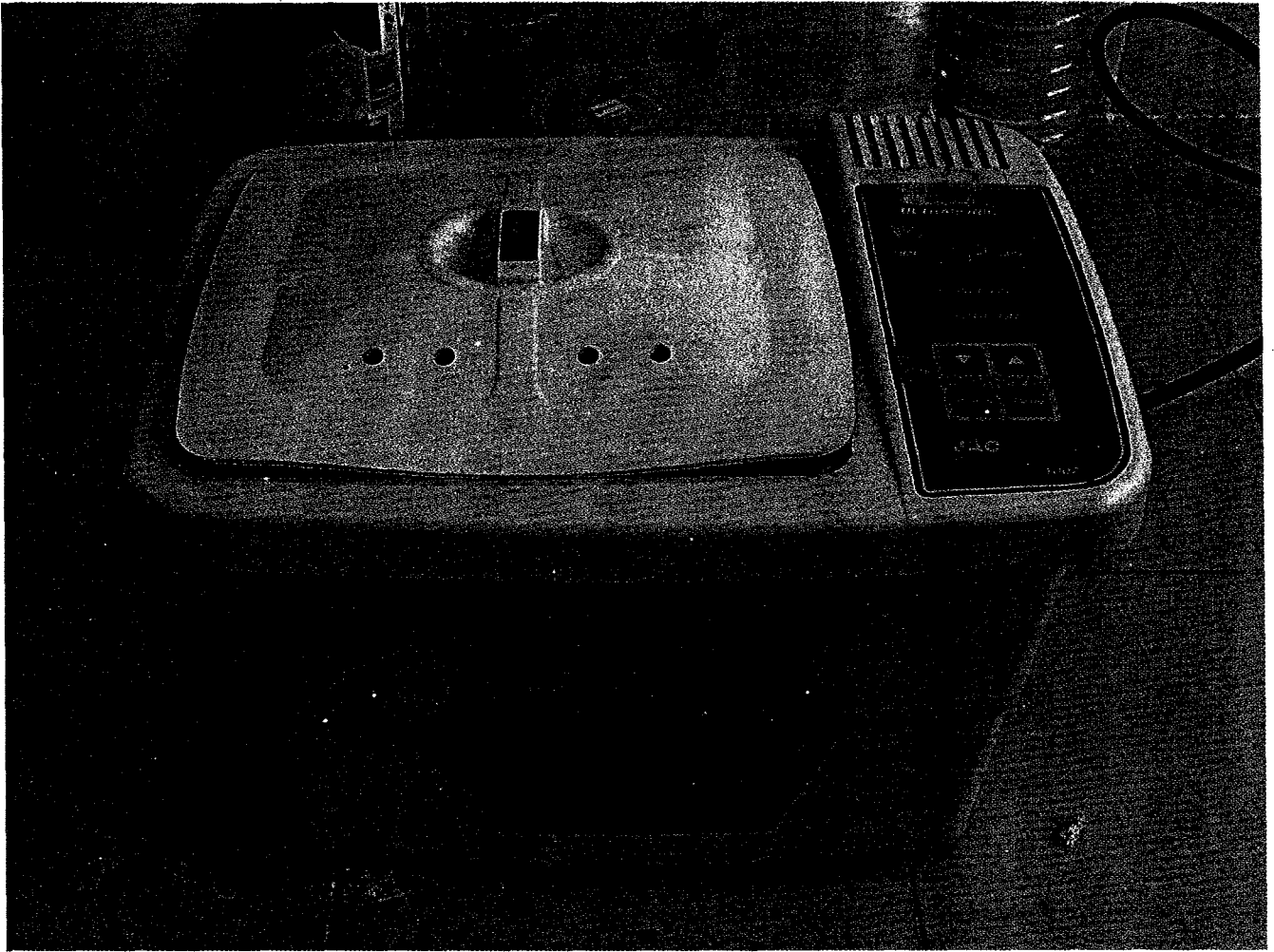
Research project on "*Ceramic Foams Core Sandwich Composite for Structural Applications*" is a collective efforts/initiative between Universiti Sains Malaysia (USM) and Construction Industry Development Board of Malaysia (CIDB). The project is fully funded by CIDB for a period of two years (15th September 2004 to 31st August 2006) for a total amount of RM452,000.00. However, the first payment of 25% of the total cost of the project was only disbursed during the first meeting on 31st January 2005. Group of research team was headed by Professor Dr. Hj. Zainal Arifin Hj. Ahmad, Dr. Hazizan Md. Akil (Co-Researcher), Mr. Mohd Al Amin Muhamad Nor (Research Officer) and Mr. Shahrul Ami Zainal Abidin (Senior Technician). The research was running smoothly as planned and all the necessities for the project (raw materials, equipments, reading materials, and small apparatuses) were available on time. However, the extension period of 4 months was sought (up to 31st December 2006) to accomplish the project. All milestones that have been set-up in the proposal were met and achieved successfully. Apart from fulfilling the prescribed milestones the group has also managed to produce several reports such as progress reports, milestones achievement reports, financial reports and final report for the project. This final report covers a broad range of the output from the research activities up to 31 December 2006. Last part of the report has also stated the ceramic foam core specifications and their potential to be commercially developed as core materials for composites.



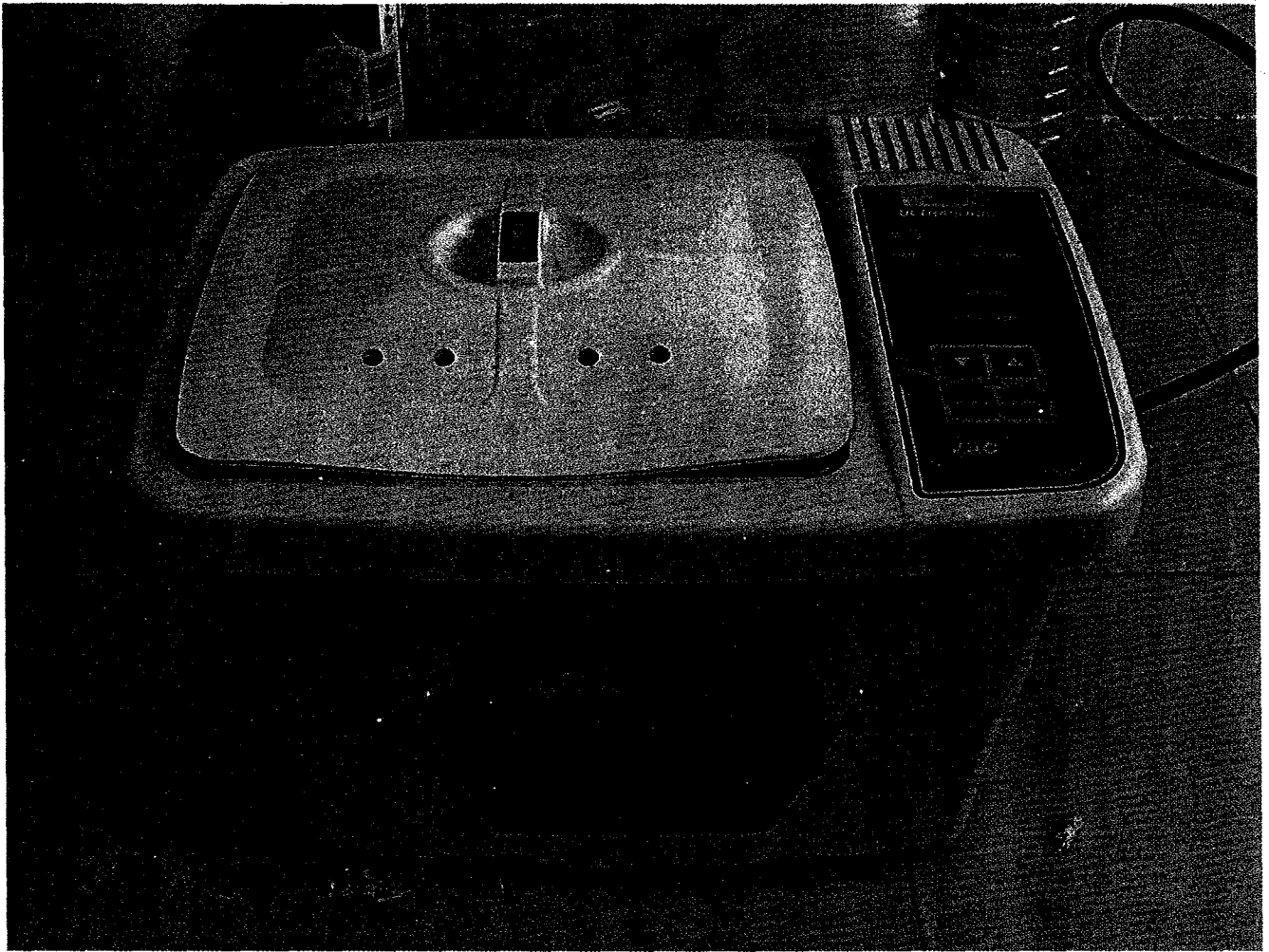
Gambar 1. Heavy duty homogenizer – Wigen Ausser



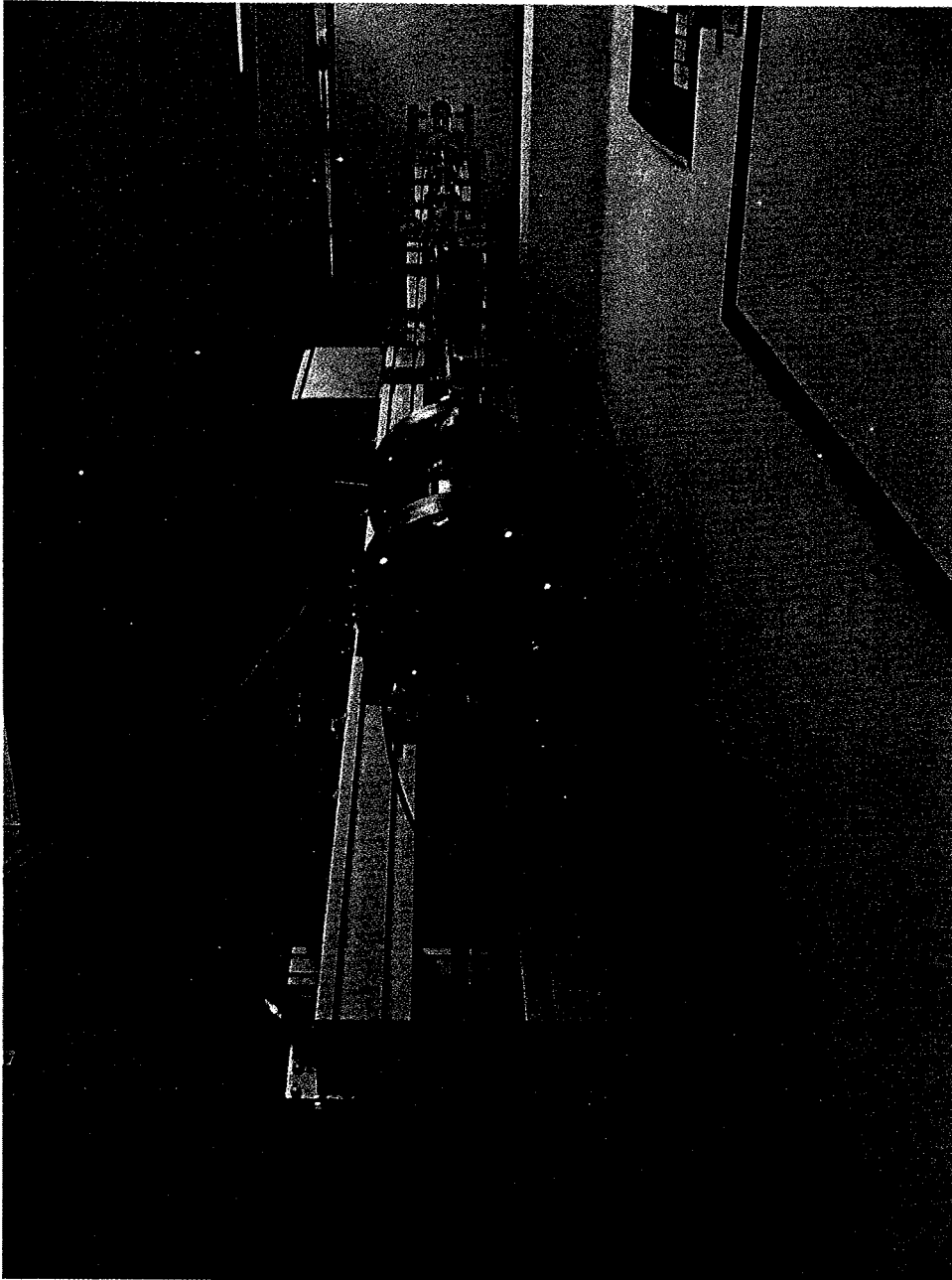
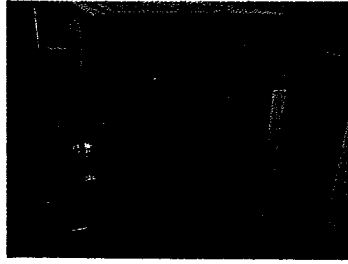
Gambar 3: Hot plate with magnetic stirrer – Lab Companion



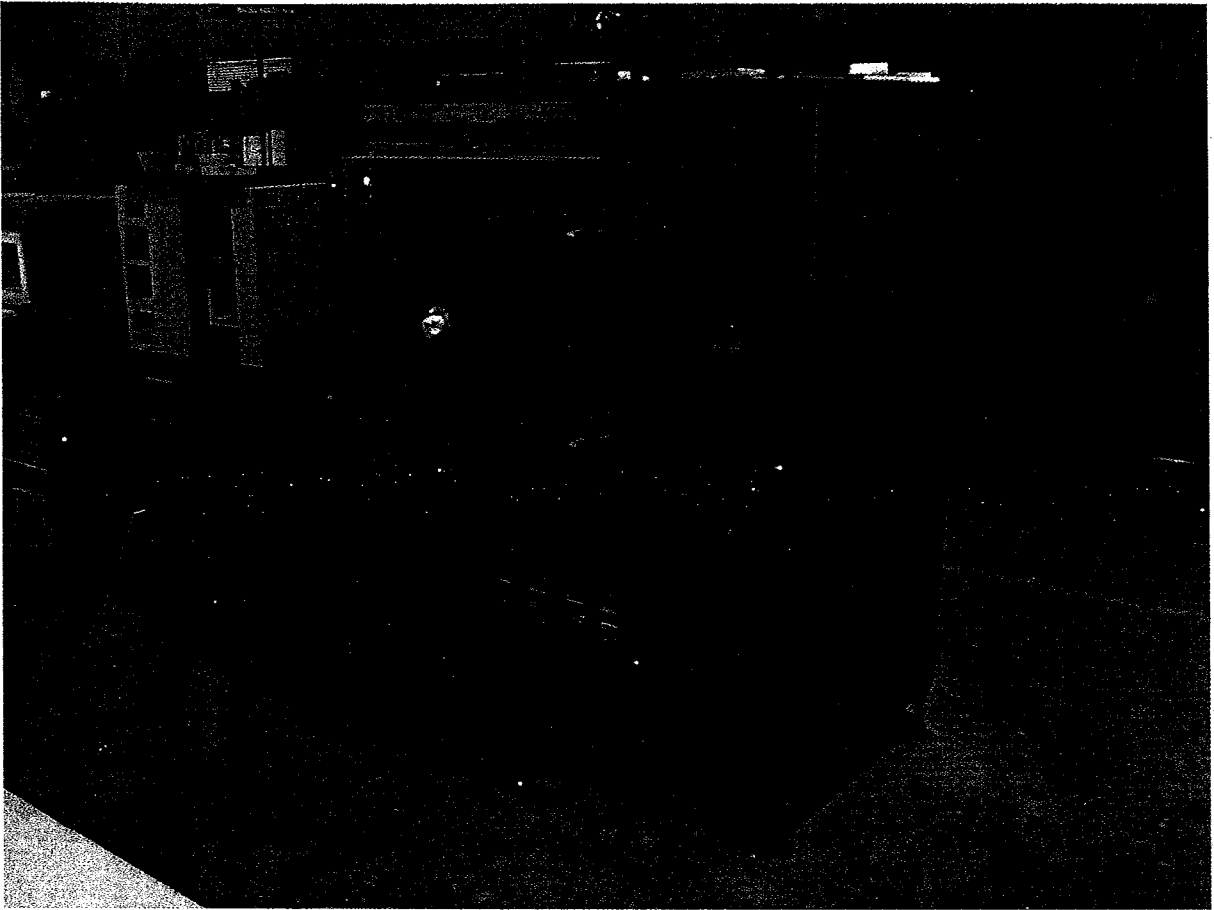
Gambar 4. Ultrasonic cleaner – Lab Companion



Gambar 4. Ultrasonic cleaner – Lab Companion



Gambar 5. Split Hopkinson Pressure Bar – KHT-52-CT



Gambar 6. High temperature furnace – Ceramtec

3.0 Senarai Penerbitan & Tesis daripada Projek Penyelidikan ini

Senarai Penerbitan

1. Mohd Al Amin Muhamad Nor, Lee Chain Hong, Zainal Arifin Ahmad, Hazizan Md Akil, Preparation and characterization of ceramic foam produced via polymeric foam replication method, *Journal of Materials Processing Technology, Volume 207, Issues 1-3, 16 October 2008, Pages 235-239*
2. Mohd Al Amin Muhamad Nor, Lee Chain Hong, Hazizan Md. Akil, Zainal Arifin Ahmad, Effect of slurries density on the properties of ceramic foam produced via polymer replication method. *Journal of Nuclear and Related Technologies, Vol. 4, Special Edition, (2007), 35-42.*
3. Mohd Al-Amin M. Nor, Hazizan Md. Akil, Shahrul Ami Zainal Abidin, Zainal Arifin Ahmad. Response of ceramic foam core sandwich composites under flexural loading, *Research achievement in the construction industry, 1st Construction Industry Research Achievement International Conference, CIRAIIC2007, 87-90 (2007)*
4. Anita Hanim Ahmadi, Mohd Al Amin Muhamad Nor, Hazizan Md. Akil, Zainal Arifin Ahmad, *Journal of Physical Science, 17(1), 21-33,2006*
5. Mohd Al-Amin Muhamad Nor, Lee Chain Hong, Hazizan Md. Akil, Zainal Arifin Ahmad. Effect of slurries density on the properties of ceramic foam produced via polymer replication method. *Proceeding of the International Conference on X-Ray and Related Techniques in Research and Industry (ICXRI2006), 29 – 30 November 2006, Palm Garden Hotel, Putrajaya*

6. Mohd Al Amin Muhamad Nor, Hazizan Md. Akil and Zainal Arifin Ahmad, Effect of template density on the properties of ceramic foam produced by polymer replication method, Proceedings of the 14th Scientific Conference Electron Microscopy Society Malaysia, 2005

7. Mohd Al Amin Muhamad Nor, Hazizan Md. Akil and Zainal Arifin Ahmad, Effect of solid loading on the porous ceramic produced via polymer foam replication method, Malaysian Journal of Microscopy,1,106-109,2005.

Tesis

Final Year Research Projects

1. Lee Chain Hong, Characterization of ceramic foam as sandwich core materials or Adhesive study in the construction of sandwich system. BEng (Materials) (Hons) (2005/06)

2. Mohd Hafiz Rahmat, Sandwich structure using big panel. BEng (Materials) (Hons) (2004/05)

3. Anita Hanim Ahmadi, Struktur sandwic teras busa seramik. BEng (Materials) (Hons) (2003/04)

PhD Research Project

4. Mohd Al Amin Muhamad Nor, Ceramic foam core sandwich composites for structural applications. PhD Thesis (will be submitted by April 2009).

Lampiran 1

Visit to Okayama University of Science and Kyushu University, Japan (4th - 7th November 2006)

Objectives:

The objectives of the visit were to establish an international collaborator on the research that related to Split Hopkinson Pressure Bar Apparatus (SHPBA) and to consult the relevant and reputable researchers on the particular research area.

Introduction and justification:

The visit was planned in order to advance the SHPBA unit which was successfully installed at School of materials and Mineral Resources Engineering (SMMRE), USM under the financial support of CREAM, CIDB. Since the unit is only one of its kinds in Malaysia, there is no alternative other than sharing experience and knowledge with researchers abroad.

Outcomes of the visit:

Summary of the outcomes of the visit to the two universities is appended in attachment. There are many other intangible outcomes which could not be put in words during the visit.

Concluding remarks of the visit:

We consider the visit a very successful one since the input that has been put forward by Professor T. Yokoyama and Associate Prof. Mitsugu Todo are really valuable to ensure that the data collected using SHPBA is accurate and at par with the previously reported data.

JABATAN BENDAHARI
UNIT KUMPULAN WANG AMANAH
UNIVERSITI SAINS MALAYSIA
KAMPUS KEJURUTERAAN
SERI AMPANGAN

PENYATA KUMPULAN WANG

TEMPOH BERAKHIR 31 OGOS 2007

PROF ZAINAL ARIFFIN AHMAD

304.PBAHAN.6050063

JUMLAH GERAN :- 452,000.00

NO PROJEK :-

PANEL :- MANUFACTURING & CONSTRUCTIO

CERAMIC FOAM CORE SANWICH COMPOSITE FOR STRUCTURAL APPLICATIONS

PENAJA :- CIDB (L111)

Tempoh Projek:01/09/2004 - 31/12/2006

Vot	Peruntukan (a)	Perbelanjaan sehingga 31/12/2006 (b)	Tanggung semasa 2007 (c)	Perbelanjaan Semasa 2007 (d)	Jumlah Perbelanjaan 2007 (c + d)	Jumlah Perbelanjaan Terkumpul (b+c+d)	Baki Peruntukan Semasa 2007 (a-(b+c+d))
77000: SUMBANGAN BADAN LUAR	0.00	0.00	0.00	0.00	0.00	0.00	0.00
78000: YURAN DAN PENDAPATAN	0.00	(167,000.00)	0.00	0.00	0.00	(167,000.00)	167,000.00
	0.00	(167,000.00)	0.00	0.00	0.00	(167,000.00)	167,000.00
11000: GAJI KAKITANGAN AWAM	0.00	53,013.37	0.00	0.00	0.00	53,013.37	(53,013.37)
21000: PERBELANJAAN PERJALANAN DAN SARAH	0.00	34,763.05	138.00	1,327.20	1,465.20	36,228.25	(36,228.25)
23000: PERHUBUNGAN DAN UTILITI	0.00	281.30	0.00	3.10	3.10	284.40	(284.40)
24000: SEWAAN	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25000: BAHAN MAKANAN	0.00	30.00	0.00	0.00	0.00	30.00	(30.00)
26000: BAHAN MENTAH & BAHAN UNTUK PENYELE	0.00	0.00	0.00	0.00	0.00	0.00	0.00
27000: BEKALAN DAN ALAT PAKAI HABIS	0.00	35,649.24	103.90	875.00	978.90	36,628.14	(36,628.14)
28000: PENYELENGGARAAN & PEMBAIKAN KECIL	0.00	0.00	0.00	0.00	0.00	0.00	0.00
29000: PERKHIDMATAN IKTISAS & HOSPITALITI	0.00	15,839.00	0.00	0.00	0.00	15,839.00	(15,839.00)
35000: HARTA-HARTA MODAL LAIN	0.00	24,579.00	0.00	0.00	0.00	24,579.00	(24,579.00)
42000: PEMBERIAN	0.00	1,350.00	0.00	0.00	0.00	1,350.00	(1,350.00)
	0.00	165,504.96	241.90	2,205.30	2,447.20	167,952.16	(167,952.16)
Jumlah Besar	0.00	(1,495.04)	241.90	2,205.30	2,447.20	952.16	(952.16)